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AGREEMENT

CONCERNING THE ADOPTION OF UNIFORM CONDITIONS OF APPROVAL AND RECIPROCAL RECOGNITION OF APPROVAL FOR MOTOR VEHICLE EQUIPMENT AND PARTS

done at Geneva on 20 March 1958

Addendum 84: Regulation No. 85 annexed to the Agreement

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UNIFORM PROVISIONS CONCERNING THE APPROVAL OF INTERNAL COMBUSTION ENGINES INTENDED FOR THE PROPULSION OF MOTOR VEHICLES OF CATEGORIES M AND N WITH REGARD TO THE MEASUREMENT OF THE NET POWER

UNITED NATIONS

Regulation No. 85

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1. SCOPE

1.1. This Regulation applies to the representation of the curve as a function of engine speed of the power at full load indicated by the manufacturer for internal combustion engines intended for the propulsion of motor vehicles of categories M and N.

1.2. The engines belong to one of the following categories:

Reciprocating piston engines (positive-ignition or compression-ignition), but excluding free piston engines;

Rotary piston engines (positive-ignition or compression-ignition).

2. DEFINITIONS

For the purposes of this Regulation:

2.1. "Approval of an engine" means the approval of an engine type with regard to its net power measured in accordance with the procedure specified in annex 4 of this Regulation;

2.2. "Engine type" means a category of an engine for installation in a motor vehicle which does not differ in such essential characteristics as those defined in annex 1 to this Regulation;

2.3. "Net power" means the power obtained on a test bench at the end of the crankshaft or its equivalent at the corresponding engine speed with the auxiliaries listed in table 1 of annex 4 to this Regulation, and determined under reference atmospheric conditions.

3. APPLICATION FOR APPROVAL

3.1. The application for approval of an engine type with regard to the measurement of the net power shall be submitted by the engine manufacturer, the vehicle manufacturer, or by his duly accredited representative.

3.2. It shall be accompanied by the following documents in triplicate: description of the engine comprising all the relevant particulars referred to in annex 1 to this Regulation.

3.3. An engine representative of the engine type to be approved, shall with the equipment prescribed in annex 4 to this Regulation be submitted to the technical service conducting the approval tests.

3.4. The competent authority shall verify the existence of satisfactory arrangements for ensuring effective control of the conformity of production before type approval is granted.

4. APPROVAL

4.1. If the power of the engine submitted for approval pursuant to this Regulation has been measured according to the specifications of paragraph 5 below, approval of the engine type shall be granted.

4.2. An approval number shall be assigned to each engine type approved. Its first two digits (at present 00 for the Regulation in its original form) shall indicate the series of amendments incorporating the most recent major technical amendments made to the Regulation at the time of issue of the approval. The same Contracting Party shall not assign the same number to another engine type.

4.3. Notice of approval or of extension or of refusal of approval of an engine type pursuant to this Regulation shall be communicated to the Parties to the 1958 Agreement applying this Regulation by means of a form conforming to the model in annex 2 to this Regulation.

4.4. There shall be affixed, conspicuously and in a readily accessible place specified on the approval form, to every engine conforming to an engine type approved under this Regulation an international approval mark consisting of:

4.4.1. A circle surrounding the letter "E" followed by the distinguishing number of the country which has granted approval; 1/

4.4.2. The number of this Regulation, followed by the letter "R", a dash and the approval number to the right of the circle prescribed in paragraph 4.4.1.

4.4.3. Alternatively instead of affixing these approval marks and symbols to the engine the manufacturer may decide that each engine type approved under this Regulation shall be accompanied by a document giving this information so that the approval marks and symbol can be attached to the vehicle.

4.5. If the engine conforms to a type approved, under one or more other Regulations annexed to the Agreement, in the country which has granted approval under this Regulation, the symbol prescribed in paragraph 4.4.1. need not be repeated; in such a case, the Regulation

and approval numbers of all the Regulations under which approval has been granted in the country which has granted approval under this Regulation shall be placed in vertical columns to the right of the symbol prescribed in paragraph 4.4.1.

4.6. The approval mark shall be clearly legible and be indelible.

4.7. The approval mark shall be placed close to the engine identification figures provided by the manufacturer.

4.8. Annex 3 to this Regulation gives examples of the arrangements of the approval mark.

5. SPECIFICATIONS AND TESTS

5.1. General

The components liable to affect the power of the engine shall be so designed, constructed and assembled as to enable the engine in normal use, despite the vibration to which it may be subjected, to comply with the provisions of this Regulation.

5.2. Description of tests

5.2.1. The net power test shall consist of a run at full throttle for positive-ignition engines and at fixed full-load fuel injection pump setting for diesel engines, the engine being equipped as specified in table 1 of annex 4 to this Regulation.

5.2.2. Measurements shall be taken at a sufficient number of engine speeds to define correctly the power curve between the lowest and the highest engine speeds recommended by the manufacturer. This range of speeds must include the speeds of revolution at which the engine produces its maximum power and its maximum torque.

5.2.3. The fuel used shall be one available on the market. In any case of dispute, the fuel shall be one of the reference fuels defined by CEC 2/:

(a) in CEC document RF-03-A-84 for compression ignition engines;

(b) one of those defined by CEC for positive ignition engines, in documents RF-01-A-84 and RF-01-A-85.

5.2.4. Measurements shall be carried out according to the provisions of annex 4 to this Regulation.

5.2.5. The test report shall contain the results and all the calculations required to find the net power, as listed in the appendix to annex 4 to this Regulation together with the characteristics of the engine listed in annex 1 to this Regulation.

5.3. Interpretation of results

The net power indicated by the manufacturer for the type of engine shall be accepted if it does not differ by more than ± 2% for maximum power and more than ± 4% at the other measurement points on the curve with a tolerance of ± 1.5% for engine speed, from the values measured by the technical service on the engine submitted for testing.

6. CONFORMITY OF PRODUCTION

6.1. Every engine bearing an approval mark as required by this Regulation shall conform to the approved engine type.

6.2. So as to verify that the conditions set out in paragraph 6.1 are complied with, appropriate production checks shall be carried out.

6.3. In particular, the holder of the approval shall:

6.3.1. Ensure the existence of procedures for the effective control of product quality;

6.3.2. Have access to the equipment necessary for checking conformity with each approved type;

6.3.3. Ensure that the data concerning the test results are recorded and that the annexed documents are available during a period to be agreed with the administrative service;

6.3.4. Analyse the results of each type of test so as to monitor and ensure the consistency of the characteristics of the product, taking into account the variations admissible in industrial manufacture;

6.3.5. Make sure that for each engine type tests are carried out in accordance with the procedures approved by the competent authority;

6.3.6. Make sure that any collection of samples demonstrating non-conformity with the test type under consideration is followed by a subsequent collection and a further test (see annex 5). All necessary steps shall be taken to re-establish due conformity of production.

6.4. The competent authorities issuing the approval may verify at any time the methods applied in each production unit for checking conformity.

6.4.1. At every inspection, the records of tests and production monitoring shall be communicated to the inspector.

6.4.2. The inspector may select at random the samples to be tested in the manufacturer's laboratory. The minumum number of samples may be determined on the basis of the results of the manufacturer's own checks.

7. PENALTIES FOR NON-CONFORMITY OF PRODUCTION

7.1. The approval granted in respect of an engine type pursuant to this Regulation may be withdrawn if the requirements set forth above are not met or if an engine bearing the approval mark does not conform to the type approved.

7.2. If a Contracting Party to the 1958 Agreement applying this Regulation withdraws an approval it has previously granted, it shall forthwith so notify the other Contracting Parties applying this Regulation, by means of a communication form conforming to the model in annex 2 to this Regulation.

8. MODIFICATION AND EXTENSION OF APPROVAL OF THE ENGINE TYPE

8.1. Every modification of an engine within an engine type with regard to the characteristics in annex 1, shall be notified to the administrative department which approved the engine type. The department may then either:

8.1.1. Consider that the modifications made are unlikely to have any appreciable adverse effect and that in any case the vehicle still complies with the requirements; or

8.1.2. Require a further test report from the technical service responsible for conducting the tests.

8.2. Confirmation or refusal of approval, specifying the alterations shall be communicated by the procedure specified in paragraph 4.3. above to the Parties to the Agreement applying this Regulation.

8.3. The competent authority issuing the extension of approval shall assign a series number for such an extension and inform thereof the other Parties to the 1958 Agreement applying this Regulation by means of a communication form conforming to the model in annex 2 to this Regulation.

9. PRODUCTION DEFINITELY DISCONTINUED

If the holder of an approval completely ceases to manufacture an engine approved in accordance with this Regulation, he shall so inform the authority which granted the approval. Upon receiving the relevant communication that authority shall inform thereof the other Parties to the 1958 Agreement applying this Regulation by means of a communication form conforming to the model in annex 2 to this Regulation.

10. NAMES AND ADDRESSES OF TECHNICAL SERVICES RESPONSIBLE FOR CONDUCTING APPROVAL TESTS, AND OF ADMINISTRATIVE DEPARTMENTS

The Parties to the Agreement which apply this Regulation shall communicate to the United Nations Secretariat the names and addresses of the technical services responsible for conducting approval tests, and/or the administrative departments which grant approval, and to which forms certifying approval or extension or refusal of approval, issued in other countries, are to be sent.

Notes

1/ 1 for Germany, 2 for France, 3 for Italy, 4 for the Netherlands, 5 for Sweden, 6 for Belgium, 7 for Hungary, 8 for the Czech and Slovak Federal Republic, 9 for Spain, 10 for Yugoslavia, 11 for the United Kingdom, 12 for Austria, 13 for Luxembourg, 14 for Switzerland, 15- (vacant), 16 for Norway, 17 for Finland, 18 for Denmark, 19 for Romania, 20 for Poland, 21 for Portugal and 22 for the Union of Soviet Socialist Republics. Subsequent numbers shall be assigned to other countries in the chronological order in which they ratify or accede to the Agreement concerning the Adoption of Uniform Conditions of Approval and Reciprocal Recognition of Approval for Motor Vehicle Equipment and parts, and the numbers thus assigned shall be communicated by the Secretary-General of the United Nations to the Contracting Parties to the Agreement.

2/ European Coordinating Council for the development of performance tests for lubricants and engine fuels (CEC). Fuel characteristics are defined in Consolidated Resolution RE3 (TRANS/SC1/WP29/78).

Annex 1

ESSENTIAL CHARACTERISTICS OF THE ENGINE AND INFORMATION CONCERNING THE CONDUCT OF TESTS 1/

1. Description of engine

1.1. Make .....

1.2. Type .....

1.3. Working principle: positive-ignition/compression-ignition/ four-stroke/two-stroke 3/

.....

1.4. Bore ..... mm

1.5. Stroke ..... mm

1.6. Number and layout of cylinders and firing order .....

1.7. Cylinder capacity ..... cm^3

1.8. Compression ratio 2/ .....

1.9. Drawings of combustion chamber and piston crown .....

1.10. Minimum cross-sectional area of inlet and outlet ports .....

1.11. Cooling system: liquid/air cooling 3/

1.11.1. Characteristics of liquid-cooling system

Nature of liquid ..... Circulating pump: yes/no 3/

Characteristics of make(s) and type(s) of the pump .....

Drive ratio .....

Thermostat: setting .....

Radiator: drawing(s) or make(s) and type(s) .....

Relief valve: pressure setting: .....

Fan: characteristics or make(s) and type(s): .....

Fan drive system: ..... drive ratio: .....

Fan cowl: .....

1.11.2. Characteristics of air-cooling system

Blower: characteristics or make(s) and type(s) ... drive ratio: ...

Air ducting (standard production): .....

Temperature regulating system: yes/no 3/ Brief description .....

1.11.3. Temperatures permitted by the manufacturer

1.11.3.1. Liquid cooling: Maximum temperature at engine outlet .....

1.11.3.2. Air cooling: Reference point .....

Maximum temperature at reference point .....

1.11.3.3. Maximum charge air temperature at intercooler outlet .....

1.11.3.4. Fuel temperature: min. ..... max. .....

1.11.3.5. Lubricant temperature: min. ..... max. .....

1.12. Supercharger: yes/no 3/ Description of the system .....

.....

1.13. Intake system

Intake manifold: ..... Description .....

Air filter: ..... Make ..... Type .....

Intake silencer: ..... Make ..... Type .....

2. Additional anti-pollution devices (if any, and if not covered by another heading)

Description and diagrams .....

3. Air intake and fuel feed

3.1. Description and diagrams of inlet pipes and their accessories (dash-pot, heating device, additional air intakes, etc.)

.....

3.2. Fuel feed

3.2.1. By carburettor(s) 3/ ..... Number .....

3.2.1.1. Make .....

3.2.1.2. Type .....

3.2.1.3. Adjustments 2/

3.2.1.3.1. Jets .....
3.2.1.3.2. Venturis .....
3.2.1.3.3. Float-chamber level ....
3.2.1.3.4. Mass of float .....
3.2.1.3.5. Float needle .....

or (Curve of fuel delivery plotted against air flow, and settings required to keep to the curve 2/ 3/

3.2.1.4. Manual/automatic choke 3/ ..... Closure setting 2/ .....

3.2.1.5. Feed pump

Pressure 2/ ..... or characteristic diagram 2/ .....

3.2.2. By fuel injection 3/ system description
Working principle: Intake manifold/direct injection
injection prechamber/swirl chamber 3/

.....

3.2.2.1. Fuel pump .....

3.2.2.1.1. Make .....

3.2.2.1.2. Type .....

3.2.2.1.3. Delivery: mm^3 per stroke at a pump speed of rpm 3/ 2/ .....
or, alternatively, a characteristic diagram 3/ 2/ .....
calibration procedure: test bench/engine 3/ .....

.....

3.2.2.1.4. Injection timing .....

3.2.2.1.5. Injection curve .....

3.2.2.2. Injector nozzle .....

3.2.2.3. Governor .....

3.2.2.3.1. Make .....

3.2.2.3.2. Type .....

3.2.2.3.3. Cut-off point under load min.$^{-1}$ .....

3.2.2.3.4 Maximum speed without load min.$^{-1}$ .....

3.2.2.3.5. Idle speed .....

3.2.2.4. Cold start device .....

3.2.2.4.1. Make .....

3.2.2.4.2. Type .....

3.2.2.4.3. System description .....

3.2.2.5. Starting aid .....

3.2.2.5.1. Make .....

3.2.2.5.2. Type .....

3.2.2.5.3. System description .....

4. Valve timing or equivalent data

4.1. Maximum lift of valves, angles of opening and closing, or timing details of alternative distribution systems, in relation to top dead centre

.....

4.2. Reference and/or setting ranges 3/ .....

5. Ignition

5.1. Ignition system type

5.1.1. Make .....

5.1.2. Type .....

5.1.3. Ignition advance curve 2/ .....

5.1.4. Ignition timing 2/ .....

5.1.5. Contact-point gap 2/ and dwell-angle 2/ 3/

6. Exhaust sytem

Description and diagrams .....

7. Lubrication system

7.1. Description of system

7.1.1. Position of lubricant reservoir: .....

7.1.2. Feed system (pump, injection into intake, mixing with fuel, etc.)

.....

7.2. Lubricating pump 3/

7.2.1. Make .....

7.2.2. Type .....

7.3. Mixture with fuel 3/

7.3.1. Percentage

7.4. Oil cooler: yes/no 3/

7.4.1. Drawing(s) or make(s) and type(s) .....

8. Electrical equipment

Generator/alternator: 3/ characteristics or make(s) and type(s)

.....

9. Other auxiliaries fitted on the engine

(Enumeration and brief description if necessary) .....

.....

10. Additional information on test conditions

10.1. Sparking plugs

10.1.1. Make .....

10.1.2. Type .....

10.1.3. Spark-gap setting .....

10.2. Ignition coil

10.2.1 Make .....

10.2.2. Type .....

10.3. Ignition condenser

10.3.1. Make .....

10.3.2. Type .....

10.4. Radio interference suppression equipment

10.4.1. Make .....

10.4.2. Type .....

11. Engine performance (declared by manufacturer)

11.1. Idle rpm 2/ ..... min.$^{-1}$

11.2. RPM at maximum power 2/ ..... min.$^{-1}$

11.3. Maximum power - kW (according to paragraph 5.3. of this Regulation)

.....

11.4 Rpm at maximum torque 2/ ..... min.$^{-1}$

11.5. Maximum torque 2/ ..... N.m.

Notes

1/ In the case of non-conventional engines and systems, particulars equivalent to those referred to here shall be supplied by the manufacturer.

2/ Specify the tolerance.

3/ Strike out what does not apply.

Annex 2

(Maximum format: A4 (210 x 297 mm))

COMMUNICATION

issued by: Name of administration:
.....
.....
.....

concerning: 2/ APPROVAL GRANTED

APPROVAL EXTENDED

APPROVAL REFUSED

APPROVAL WITHDRAWN

PRODUCTION DEFINITELY DISCONTINUED

of an engine pursuant to Regulation No. 85.

Approval No. ..... Extension No. .....

1. Trade name or mark of engine: .....
2. Engine type: .....
3. Manufacturer's name and address: .....
4. If applicable, name and address of manufacturer's representative: .....
   .....
5. Engine submitted for approval on: .....
6. Technical service responsible for conducting approval tests: .....
   .....
7. Date of report issued by that service: .....
8. Number of report issued by that service: .....

9. Location of the approval mark: .....

10. Reason(s) for extension of approval (if applicable): 2/ .....

11. Declared figures

11.1 Maximum net power: ..... kW, at ..... $min.^{-1}$

11.2 Maximum net torque: ..... N.m, at ..... $min.^{-1}$

12. Essential characteristics of the engine type:

Operating principle: four stroke/two stroke 2/

Number and layout of cylinders: .....

Cylinder capacity: ..... cm^3

Fuel feed: carburettor/indirect injection/direct injection 2/

Pressure-charger device: Yes/No 2/

Exhaust gas cleaning device: Yes/No 2/

13. Approval granted/extended/refused/withdrawn 2/

14. Place: .....

15. Date: .....

16. Signature: .....

17. The documents filed with the request for approval or extension may be obtained on request.

Notes

1/ Distinguishing number of the country which has granted/extended/refused/withdrawn approval (see approval provisions in the Regulation).

2/ Strike out what does not apply.

Annex 3

ARRANGEMENTS OF APPROVAL MARKS

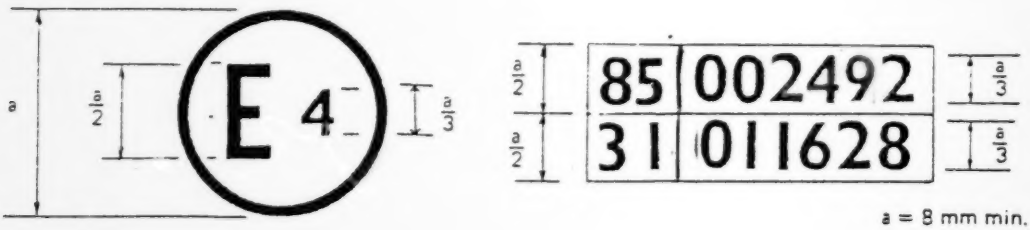
Model A

(see paragraph 4.4 of this Regulation)

The above approval mark affixed to an engine shows that the engine type concerned has been approved in the Netherlands (E 4) with regard to the measurement of the net power, pursuant to Regulation No. 85 and under the approval number 002492. The approval number indicates that the approval was granted in accordance with the requirements of Regulation No. 85 in its original form.

Model B

(see paragraph 4.5 of this Regulation)



The above approval mark affixed to a vehicle shows that the vehicle type concerned has been approved in the Netherlands (E 4) pursuant to Regulations Nos. 85 and 31. 1/ The first two digits of the approval numbers indicate that, at the dates when the respective approvals were granted, Regulation No. 85 had not been modified, and Regulation No. 31 already included the 01 series of amendments.

Note

1/ The second number is given merely as an example.

Annex 4

METHOD FOR MEASURING INTERNAL COMBUSTION ENGINE NET POWER

1. These provisions apply to the method for representing the power curve at full load of an internal combustion engine as a function of engine speed.

2. TEST CONDITIONS

2.1. The engine shall have been run-in according to the manufacturer's recommendations.

2.2. If the power measurement can be carried out only on an engine with the gear-box mounted, the efficiency of the gear-box shall be taken into account.

2.3. Auxiliaries

2.3.1. Auxiliaries to be fitted

During the test, the auxiliaries necessary for the engine operation in the intended application (as listed in table 1) shall be installed on the test bench as far as possible in the same position as in the intended application.

2.3.2. Auxiliaries to be removed

Certain vehicle accessories necessary only for operation of the vehicle and which may be mounted on the engine shall be removed for the test. The following non-exhaustive list is given as a sample:

air compressor for brakes
power steering compressor
suspension compressor
air-conditioning system

Where accessories cannot be removed, the power they absorb in the unloaded condition may be determined and added to the measured engine power.

TABLE 1 - AUXILIARIES TO BE FITTED FOR THE TEST TO DETERMINE NET POWER OF ENGINE

("Standard-production equipment" means equipment provided by the manufacturer for a particular application)

No.	Auxiliaries	Fitted for net power test
1	Intake system	
	Intake manifold)	
	Crankcase emission control system)	Yes, standard production equipment
	Air filter)	Yes, standard production equipment
	Intake silencer)	
	Speed limiting device)	1a/
2	Induction heating device of intake manifold	Yes, standard production equipment. If possible, to be set in the most favourable position.
3	Exhaust system	
	Exhaust purifier)	
	Exhaust manifold)	
	Supercharging device)	Yes, standard production
	Connecting pipes 1b/)	equipment
	Silencer 1b/)	
	Tail pipe 1b/)	
	Exhaust brake 2/)	
4	Fuel supply pump 3/	Yes, standard production equipment
5	Carburettor	
	Electronic control system, air flow meter, etc. ... (if fitted)	Yes, standard production equipment
	Pressure reducer)	
	Evaporator)	Equipment for gas engines
	Mixer)	
6	Fuel injection equipment (petrol and diesel)	
	Prefilter)	
	Filter)	
	Pump)	
	High pressure pipe)	

TABLE 1 (continued)

No.	Auxiliaries	Fitted for net power test
6	Injector Air intake valve, 4/ if fitted Electronic control system air, flow meter, etc. ... if fitted Governor/control system. Automatic full-load stop for the control rack depending on atmospheric conditions	Yes, standard production equipment
7	Liquid cooling equipment	
	Engine bonnet Bonnet air outlet	No
	Radiator Fan 5/ 6/ Fan cowl Water pump Thermostat 7/	Yes, 5/ standard production equipment
8	Air cooling	
	Cowl Blower 5/ 6/	Yes, standard production equipment
	Temperature regulating device	Yes, standard production equipment
9	Electrical equipment	Yes, 8/ standard production equipment
10	Supercharging equipment (if fitted)	
	Compressor driven either directly by the engine, and/or by the exhaust gases Charge air cooler 9/ Coolant pump or fan (engine driven) Coolant flow control devices (if fitted)	Yes, standard production equipment
11	Auxiliary test bench fan	Yes, if necessary
12	Anti-pollution devices 10/	Yes, standard production equipment

1a/ The complete intake system shall be fitted as provided for the intended application:

where there is a risk of an appreciable effect on the engine power;

in the case of two-stroke and positive-ignition engines;

when the manufacturer requests that this should be done.

In other cases, an equivalent system may be used and a check should be made to ascertain that the intake pressure does not differ by more than 100 Pa from the limit specified by the manufacturer for a clean air filter.

1b/ The complete exhaust system shall be fitted as provided for the intended application:

where there is a risk of an appreciable effect on the engine power;

in the case of two-stroke and positive-ignition engines;

when the manufacturer requests that this should be done.

In other cases, an equivalent system may be installed provided the pressure measured at the exit of the engine exhaust system does not differ by more than 1,000 Pa from that specified by the manufacturer.

The exit from the engine exhaust system is defined as a point 150 mm downstream from the termination of the part of the exhaust system mounted on the engine.

2/ If an exhaust brake is incorporated in the engine, the throttle valve must be fixed in a fully open position.

3/ The fuel feed pressure may be adjusted, if necessary, to reproduce the pressures existing in the particular engine application (particularly when a "fuel return" system is used).

4/ The air intake valve is the control valve for the pneumatic governor of the injection pump. The governor of the fuel injection equipment may contain other devices which may affect the amount of injected fuel.

5/ The radiator, the fan, the fan cowl, the water pump and the thermostat shall be located on the test bench in the same relative positions as on the vehicle. The cooling liquid circulation shall be operated by the engine water pump only.

Cooling of the liquid may be produced either by the engine radiator or by an external circuit, provided that the pressure loss of this circuit and the pressure at the pump inlet remain substantially the same as those of the engine cooling system. The radiator shutter, if incorporated, shall be in the open position.

Where the fan, radiator and cowl system cannot conveniently be fitted to the engine, the power absorbed by the fan when separately mounted in its correct position in relation to the radiator and cowl (if used), must be determined at the speeds corresponding to the engine speeds used for measurement of the engine power either by calculation from standard characteristics or by practical tests. This power, corrected to the standard atmospheric conditions defined in paragraph 6.2., should be deducted from the corrected power.

6/ Where a disconnectable or progressive fan or blower is incorporated, the test shall be made with the disconnectable fan (or blower) disconnected or with the progressive fan or blower running at maximum slip.

7/ The thermostat may be fixed in the fully open position.

8/ Minimum power of the generator: the power of the generator shall be limited to that necessary for the operation of accessories which are indispensable for the operation of the engine. If the connection of a battery is necessary, a fully charged battery in good order must be used.

9/ Charge air cooled engines shall be tested with charge air cooling, whether liquid or air cooled, but if the engine manufacturer prefers, a test bench system may replace the air cooled cooler. In either case, the measurement of power at each speed shall be made with the same pressure drop and temperature drop of the engine air across the charge air cooler on the test bench system as those specified by the manufacturer for the system on the complete vehicle.

10/ They may include, for example, EGR* system, catalytic convertor, thermal reactor, secondary air supply system and fuel evaporation protecting system.

2.3.3. Compression-ignition engine starting auxiliaries

For the auxiliaries used in starting compression-ignition engines, the two following cases shall be considered:

(a) electric starting. A generator is fitted and supplies, where necessary, the auxiliaries essential for engine operation;

(b) starting other than by electrical means. If there are any electrically operated accessories essential for engine operation for which a generator is fitted. Otherwise, it is removed.

In either case, the system for producing and storing the energy necessary for starting is fitted and operates in the unloaded condition.

---

* Exhaust gas recirculation.

2.4. Setting conditions

The setting conditions for the test to determine the net power are indicated in table 2.

TABLE 2 - SETTING CONDITIONS

1	Setting of carburettor(s)	In accordance with the manufacturer's production specifications and used without further alteration for the particular application
2	Setting of injection pump delivery system	
3	Ignition or injection timing (timing curve)	
4	Governor setting	
5	Emission control devices	

3. DATA TO BE RECORDED

3.1. Data to be recorded are those indicated in paragraph 4 of the appendix to this annex. Performance data shall be obtained under stabilized operating conditions with an adequate fresh air supply to the engine. Combustion chambers may contain deposits, but in limited quantity. Test conditions, such as inlet air temperature, shall be selected as near to reference conditions (see para. 5.2 of this annex) as possible in order to minimize the magnitude of the correction factor.

3.2. The temperature of the inlet air to the engine (ambient air) shall be measured within 0.15 m upstream of the point of entry to the air cleaner, or, if no air cleaner is used, within 0.15 m of the air inlet horn. The thermometer or thermocouple shall be shielded from radiant heat and placed directly in the air stream. It shall also be shielded from fuel spray-back. A sufficient number of locations shall be used to give a representative average inlet temperature.

3.3. No data shall be taken until torque, speed and temperatures have been maintained substantially constant for at least one minute.

3.4. The engine speed during a run or reading shall not deviate from the selected speed by more than + 1% or + 10 min-1, whichever is greater.

3.5. Observed brake load, fuel consumption and inlet air temperature data shall be taken simultaneously and shall be the average of two stabilized consecutive values which do not vary more than 2% for the brake load.

3.6. The temperature of the coolant at the outlet from the engine shall be kept at the value specified by the manufacturer. If no temperature is specified by the manufacturer, the temperature shall be 353 K + 5 K. For air-cooled engines, the temperature at a point indicated by the manufacturer shall be kept within $\pm \frac{0}{20}$ K of the maximum value specified by the manufacturer in the reference conditions.

3.7. The fuel temperature shall be measured at the inlet to the carburettor or at the fuel injection system and maintained within the limits established by the engine manufacturer.

3.8. The temperature of the lubricating oil measured in the oil pump or at the outlet from the coil cooler, if fitted, shall be maintained within the limits established by the engine manufacturer.

3.9. An auxiliary regulating system may be used if necessary to maintain the temperatures within the limits specified in paragraphs 3.6, 3.7 and 3.8 above of this annex.

4. ACCURACY OF MEASUREMENTS

4.1. Torque: ± 1% of measured torque.

The torque measuring system shall be calibrated to take friction losses into account. The accuracy in the lower half of the measuring range of the dynamometer bench may be ± 2% of measured torque.

4.2. Engine speed: 0.5% of measured speed.

4.3. Fuel consumption: ± 1% of measured consumption.

4.4. Fuel temperature: ± 2 K.

4.5. Engine inlet air temperature: ± 2 K.

4.6. Barometric pressure: ± 100 Pa.

4.7. Pressure in intake-duct: ± 50 Pa.

4.8. Pressure in exhaust duct: ± 200 Pa.

5. POWER CORRECTION FACTORS

5.1. Definition

The power correction factor is the coefficient α to determine the engine power under the reference atmospheric conditions specified in 5.2 below.

$$P_o = \mathcal{L} \cdot P$$

where

P_o is the corrected power (i.e. power under reference atmospheric conditions)

$\mathcal{L}$ is the correction factor ($\mathcal{L}_a$ or $\mathcal{L}_d$)

P is the measured power (test power)

5.2. Reference atmospheric conditions

5.2.1. Temperature (T_o) : 298 K (25°C)

5.2.2. Dry pressure (P_{so}) : 99 kPa

Note: The dry pressure is based on a total pressure of 100 kPa and a water vapour pressure of 1 kPa.

5.3. Test atmospheric conditions

The atmospheric conditions during the test shall be the following:

5.3.1. Temperature (T)

For positive-ignition engines $288\ K \leqslant T \leqslant 308\ K$
For diesel engines $283\ K \leqslant T \leqslant 313\ K$

5.3.2. Pressure (p_s)

$80\ kPa \leqslant p_s \leqslant 110\ kPa$

5.4. Determination of correction factor α_a and α_d 1/

5.4.1. Naturally aspirated or pressure-charged positive-ignition engine factor α_a

The correction factor α_a is obtained by applying the formula:

$$\alpha_a = \left(\frac{99}{P_s}\right)^{1.2} \left(\frac{T}{298}\right)^{0.6} \quad 2/$$

where

P_s is the total dry atmospheric pressure in kilopascals (kPa); that is to say, the total barometric pressure minus water vapour pressure

T is the absolute temperature in kelvins (K) of the air drawn in by the engine.

Conditions to be complied with in the laboratory

For a test to be valid, the correction factor α_a must be such that $0.93 \leqslant \alpha_a \leqslant 1.07$

If these limits are exceeded, the corrected value obtained shall be given and the test conditions (temperature and pressure) precisely stated in the test report.

5.4.2. Diesel engines - Factor α_d

The power correction factor (α_d) for diesel engines at constant fuel rate is obtained by applying the formula:

where $\alpha_d = (f_a)^{f_m}$

f_a is the atmospheric factor

f_m is the characteristic parameter for each type of engine and adjustment

5.4.2.1. Atmospheric factor f_a

This factor indicates the effects of environmental conditions (pressure, temperature and humidity) on the air drawn in by the engine. The atmospheric factor formula differs according to the type of engine.

5.4.2.1.1. Naturally aspirated and mechanically supercharged engines

$$f_a = \left(\frac{99}{P_s}\right)\left(\frac{T}{298}\right)^{0.7}$$

5.4.2.1.2. Turbocharged engines with or without cooling of inlet air

$$f_a = \left(\frac{99}{P_s}\right)^{0.7}\left(\frac{T}{298}\right)^{1.5}$$

5.4.2.2. Engine factor f_m

f_m is a function of q_c (fuel flow corrected) as follows:

$$f_m = 0.036\ q_c - 1.14$$

where: $q_c = q/r$

where:

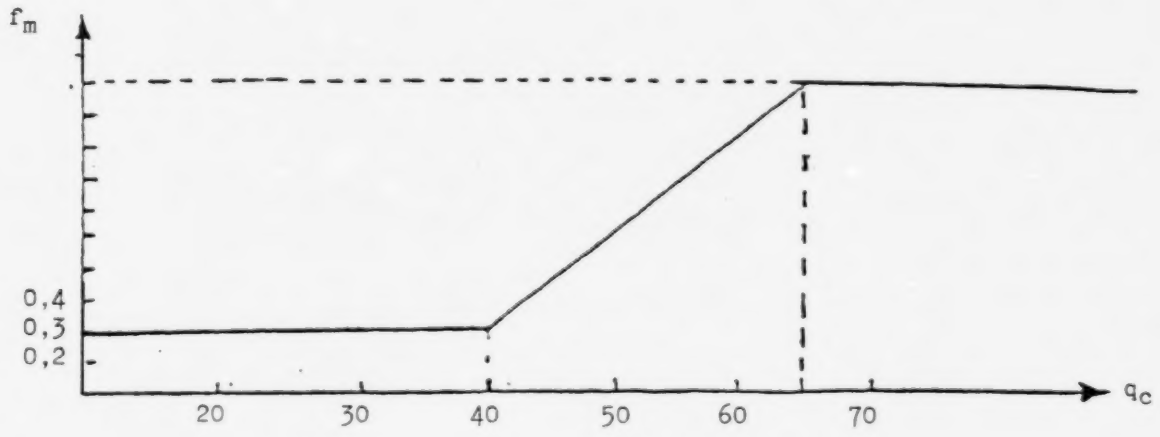
q is the fuel flow in miligram per cycle per litre of total swept volume (mg/(l.cycle))

r is the pressure ratio of compressor outlet and compressor inlet (r = 1 for naturally aspirated engines)

This formula is valid for a value interval of q_c included between 40 mg/(l.cycle) and 65 mg/(l.cycle).

For q_c values lower than 40 mg/(l.cycle), a constant value of f_m equal to 0.3 (f_m = 0.3) will be taken.

For q_c values higher than 65 mg/(l.cycle), a constant value of f_m equal to 1.2 (f_m = 1.2) will be taken (see figure):



5.4.2.3. Conditions to be complied with in the laboratory

For a test to be valid; the correction factor α_d must be such that $0.9 \leqslant \alpha_d \leqslant 1.1$

If these limits are exceeded, the corrected value obtained shall be given and the test conditions (temperature and pressure) precisely stated in the test report.

Notes

1/ The tests may be carried out in air-conditioned test rooms where the atmospheric conditions may be controlled.

2/ In the case of engines fitted with automatic air temperature control, if the device is such that at full load at 25°C no heated air is added, the test shall be carried out with the device fully closed. If the device is still operating at 25°C then the test is made with the device operating normally and the exponent of the temperature term in the correction factor shall be taken as zero (no temperature correction).

Annex 4 - Appendix

RESULTS OF TESTS FOR MEASURING NET ENGINE POWER

This form shall be completed by the laboratory performing the test.

1. Test conditions

1.1. Pressures measured at maximum power

1.1.1. Total barometric pressure: ..... Pa

1.1.2. Water vapour pressure: ..... Pa

1.1.3. Exhaust pressure: ..... Pa

1.2. Temperatures measured at maximum power

1.2.1. of the intake air: ..... K

1.2.2. at the outlet of the engine intercooler: ..... K

1.2.3. of the cooling fluid

1.2.3.1. at the engine cooling fluid outlet: ..... K 1/

1.2.3.2. at the reference point in the case of air cooling: ..... K 1/

1.2.4. of the lubricating oil: ..... K (indicate point of measurement)

1.2.5. of the fuel

1.2.5.1. at the fuel pump inlet: ..... K

1.2.5.2. in the fuel consumption measuring device: ..... K

1.3. Characteristics of the dynamometer

1.3.1. Make: ..... Model: .....

1.3.2. Type: .....

2. Fuel

2.1. For positive-ignition engines operating on liquid fuel

2.1.1. Make: .....

2.1.2. Specification: .....

2.1.3. Anti-knock additive (lead, etc): .....

2.1.3.1. Type: .....

2.1.3.2. Content: ..... mg/l

2.1.4. Octane number RON: ..... (ASTM D 26 99-70)

2.1.4.1. Specific density: ..... g/cm^3 at 288 K

2.1.4.2. Lower calorific value: ..... kJ/kg

2.2. For positive-ignition engines operating on gaseous fuel

2.2.1. Make: .....

2.2.2. Specification: .....

2.2.3. Storage pressure: ..... bar

2.2.4. Utilization pressure: ..... bar

2.2.5. Lower calorific value: ..... kJ/kg

2.3. For compression-ignition engines operating on gaseous fuels

2.3.1. Feed system: gas .....

2.3.2. Specification of gas used: .....

2.3.3. Fuel oil/gas proportion: .....

2.3.4. Lower calorific value: .....

2.4. For compression-ignition engines operating on liquid fuel

2.4.1. Make: .....

2.4.2. Specification of fuel used: .....

2.4.3. Cetane number (ASTM D 976-71) .....

2.4.4. Specific density: ..... g/cm^3 at 288 K

2.4.5. Lower calorific value: ..... kJ/kg

3. Lubricant

3.1. Make: .....

3.2. Specification: .....

3.3. SAE viscosity: .....

4. Detailed results of measurements*

Engine speed, min-1		
Measured torque, Nm		
Measured power, kW		
Measured fuel flow, g/h		
Barometric pressure, kPa		
Water vapour pressure, kPa		
Inlet air temperature, K		
Power to be added for auxiliaries in excess of table 1, kW (No.1 / No.2 / No.3)		
Power correction factor		
Corrected brake power, kW (with/without 1/ fan)		
Power of fan, kW (to be subtracted if fan not fitted)		
Net power, kW		
Net torque, Nm		
Corrected specific fuel consumption g/(kWh) 2/		
Cooling liquid temperature at outlet, K		
Lubricating oil temperature at measuring point, K		
Air temperature after pressure-charger, K 3/		
Fuel temperature at injection pump inlet, K		

* The characteristic curves of the net power and the net torque shall be drawn as a function of the engine speed.

Air temperature after charge air cooler, K 3/		
Pressure after pressure-charger, kPa 3/		
Pressure after charge air cooler, kPa		

Notes

1/ Delete as appropriate.

2/ Calculated with the net power for compression-ignition and positive-ignition engines, in the latter case multiplied by the power correction factor.

3/ Delete where inapplicable.

Annex 5

CHECKS ON CONFORMITY OF PRODUCTION

1. GENERAL

These requirements are consistent with tests to be held to check conformity of production, according to paragraph 6.3.6.

2. TEST PROCEDURES

The methods of testing and measuring instruments shall be those described in annex 4 to this Regulation.

3. COLLECTION OF SAMPLES

One engine has to be chosen. If after the test of paragraph 5.1 below, the engine is not considered as conforming to the requirements of this Regulation, two more engines have to be tested.

4. MEASUREMENT CRITERIA

During the tests to verify conformity of production the power shall be measured at two engine speeds S1 and S2 corresponding respectively to the measurement points of maximum power and maximum torque accepted for type approval. At these two engine speeds, which are subject to a tolerance of ± 5%, the net power measured at at least one point within the ranges S1 ± 5% and S2 ± 5% shall not differ by more than ± 5% from the approval figure.

5. EVALUATION OF RESULTS

5.1. If the net power of the engine tested pursuant to paragraph 2 above fulfils the requirement of paragraph 4 above, the production is considered to conform to the type approval.

5.2. If the requirements of paragraph 4 above are not fulfilled two more engines are tested in the same way.

5.3. If the net power figure of the second and/or third engine of paragraph 5.2 does not fulfil the requirements of paragraph 4 above, the production shall be considered not to conform to the requirements of this Regulation and the provisions of paragraph 7.1 shall be put into effect.